JPRS L/9641

2 April 1981

East Europe Report

SCIENTIFIC AFFAIRS

(FOUO 4/81)

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EAST EUROPE REPORT

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CONTENTS

GABCIKOVO-NAGYMAROS HYDROELECTRIC PROJECT DESCRIBED

Prague GEODETICKY A KARTOGRAFICKY OBZOR in Slovak No 11, Nov 80 pp 273-279

[Article by Eng Milan Balaz, Hydroconsult, Bratislava: "Geodetic Work for the System of Hydraulic Installations on the Danube"]

[Excerpts]

Introduction

On 30 June 1978 the agreement between the Czechoslovak Socialist Republic and the Hungarian People's Republic to build and operate the Gabcikovo-Nagymaros system of hydraulic installations (Fig 1) went into effect. According to this agreement, the two parties are to build a system of hydraulic installations as a joint investment project, consisting of the Gabcikovo hydraulic installation and the Nagymaros hydraulic installation, which will form a unified operating system of facilities.

The composition of the main facilities in the system is as follows:

The Gabcikovo installation has the following main components:

--the Hrusov-Dunakiliti Reservoir on a section of the Danube in Czechoslovak and Hungarian territory;

--the Dunakiliti Dam (Fig 2) and auxiliary lock on the Hungarian side;

--the bypass channel, i.e., a water supply and drainage channel on the Czechoslovak side;

--a station on the bypass channel at Gabcikovo on the Czechoslovak side (Fig 3), which will consist of a hydroelectric power station with an installed capacity of 720 megawatts, two locks, and auxiliary facilities;

--the improved old Danube channel, a dredged and regulated channel of the Danube in the joint Czechoslovak-Hungarian section.

The Nagmaros hydroelectric installation includes the following:

--a reservoir and the necessary protective works on a section of the Danube and on sections of tributaries affected by rising water levels on the Czechoslovak and Hungarian sides. On the Czechoslovak side these include 8 areas requiring protective works: the lower Ipel, the lower Hron, the Kravany, the Iza, Komarno city, Komarno-Medvedov, the left bank of the Vah, the right bank of the Vah, and the Little Danube;

--a station on the Hungarian side (Fig 4) which consists of a dam, a hydroelectric plant with an installed capacity of 158 MW, two locks and auxiliary works;

--the deepened and regulated channel of the Danube in the Hungarian section of the river.

The concept of the system of hydraulic installations includes a joint investment program. Detailed technical data on the system are given in the joint draft agreement developed in accordance with the agreement between the Czechoslovak and Hungarian governments.

The work on the joint investment project by the two sides is so organized that the energy units will be put into operation in 1986-1990.

The enormous size of the joint investment required that considerable geodetic work be done on both Czechoslovak and Hungarian territory, and that the basis be laid for working out the joint draft agreement and for working out the performance plans required for the construction itself.

Geodetic Work for the Joint Draft Agreement

It was agreed that each country would use its own coordinate system for the location geodetic work:

--on the Czechoslovak side the Unified Trigonometric Survey Network (S-JTSK) will be used;

--on the Hungarian side the Budapest Stereographic national coordinates system will be used. The Nagymaros station is an exception, because there a local coordinate system supplementary to the national coordinate system will be used.

Some facilities in the system cross national boundaries (i.e., are partly in Czechoslovakia and partly in Hungary). Accordingly it has been agreed that positional and elevation base junction points with permanent stabilization will be built in 5 locations, with their coordinates determined in the Czechoslovak and Hungarian coordinate systems and their elevations in the Bvp system. These locations are: Cunovo-Rajka, Hrusov-Dunakiliti, Palkovicovo, Salka-Letkes, and Lela-Letkes. At each location two points will be established on the Czechoslovak side and two in the Hungarian side. The coordinates of the points have been determined with a trigonometric precision of the 5th order, and the elevations by the VPM method.

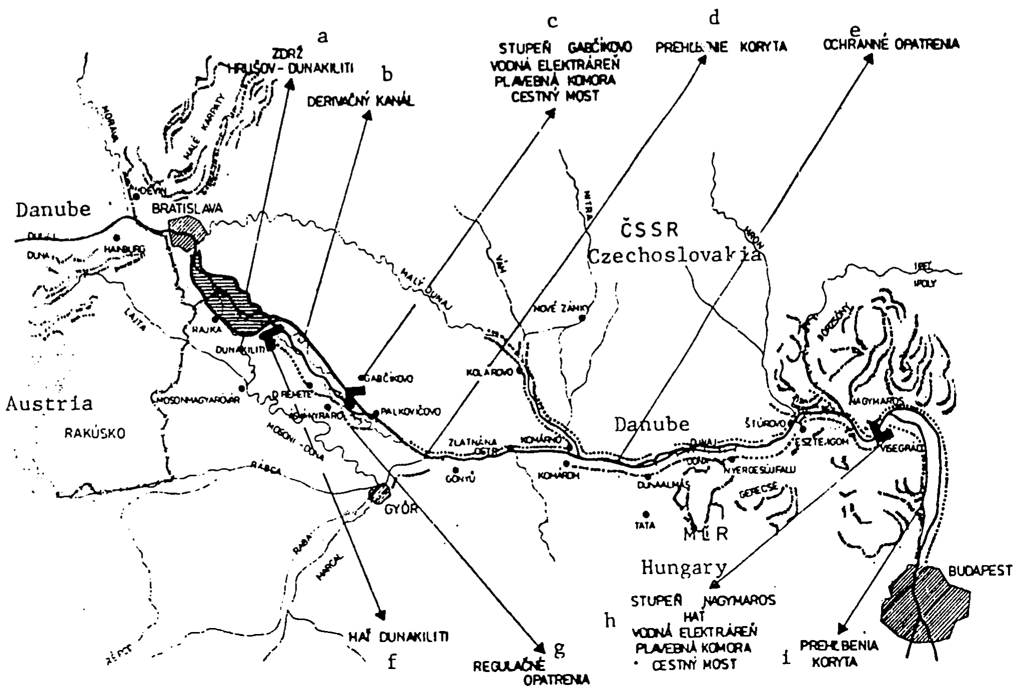

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Fig. 1. Survey of the location of the system of hydraulic installations

Key:
- a. Hrusov-Dunakiliti Reservoir
- b. Bypass channel
- c. Gabcikovo Station: hydroelectric power station, lock, highway bridge
- d. Dredged channel
- e. Protective works
- f. Dunakiliti Dam
- g. Regulating installations
- h. Nagymaros Station: dam, hydroelectric power station, lock, highway bridge
- i. Dredged channel

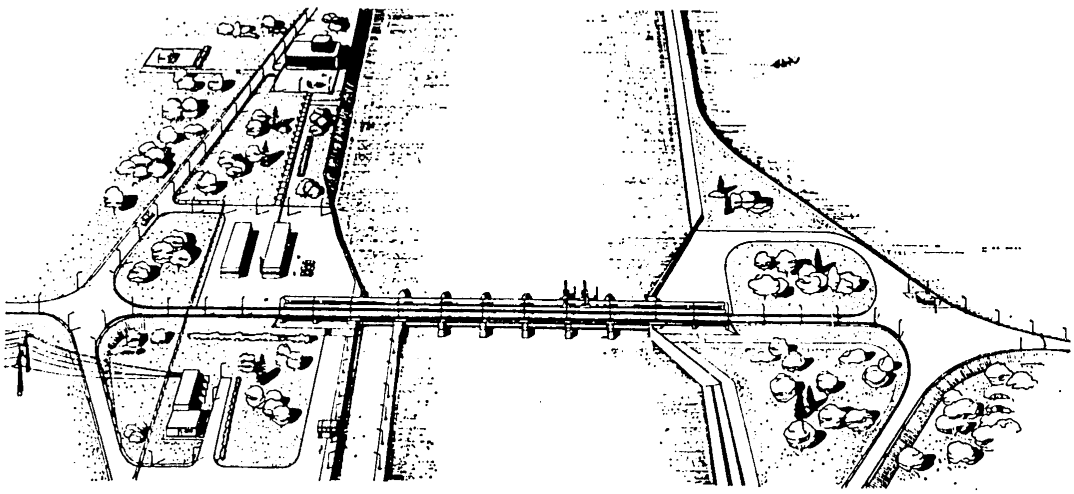

Fig. 2. The Dunakiliti Dam

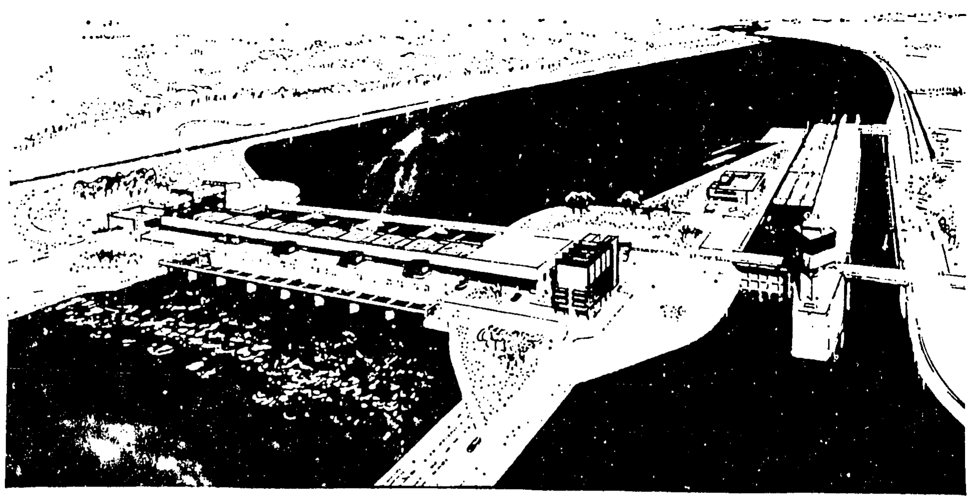

Fig. 3. ˀabcikovo Station

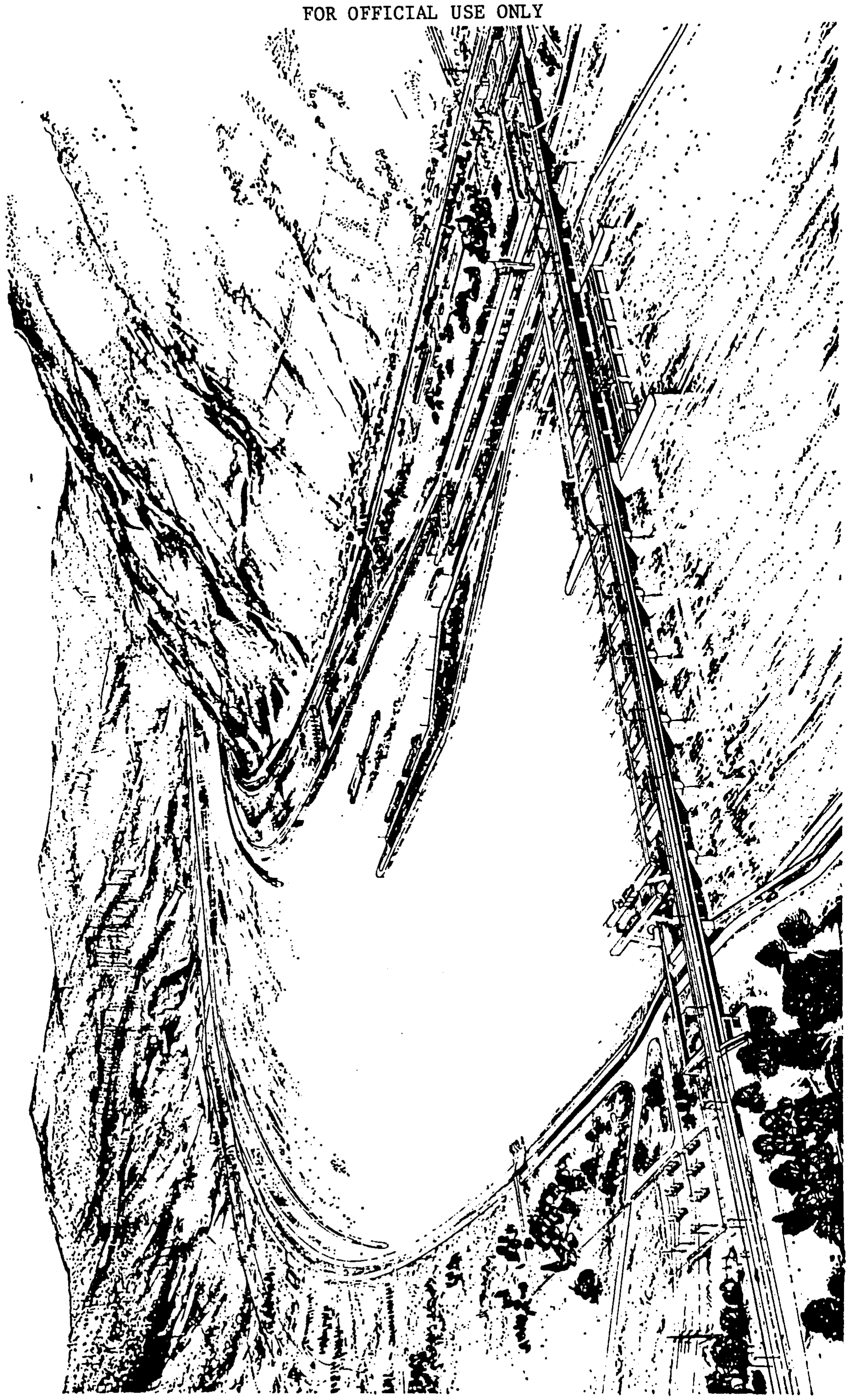

Fig. 4. Nagymaros Station

Geodetic work associated with the control measurement of elevation points in the national leveling system and with determination of the base position and elevation junction points was performed on the Czechoslovak side by members of the Geodetic Committee, the national enterprise in Bratislava (GU), and on the Hungarian side by members of BGTV in Budapest. The two sides have exchanged the relevant documents.

Base maps with scales of 1:10,000 and 1:50,000 were used as the map base for the placement of the entire system of hydraulic installations within the framework of the joint draft agreement. The planned locations were overprinted in red on these base maps, with suitable labels and enumeration of the main facilities and sections of the Gabcikovo-Nagymaros Hydraulic Installations System. The labels are given in both Slovak and Hungarian.

Conclusion

In conclusion it must be stated that such extensive geodetic work has never before been done on any hydraulic project in this country. It was an extremely demanding task to organize and coordinate all project requirements with the capacities which were available for the purpose both in HYCO and in the units of the Slovak Institute of Geodesy and Cartography (SUGK). We can only state that thanks to close cooperation among the organizations concerned, particularly SUGK, the office of Geodesy and Cartography in Bratislava, GU, the Research Institute of Geodesy and Cartography, the Slovak Cartographic Office the Geodezia national enterprise, the national enterprise in Bratislava and the investor from VVIP, all required geodetic work was arranged for by agreement and is gradually being performed.

We expect that in the future we will be able to offer further, more detailed information and findings regarding the geodetic work involved in the construction of the facilities in the System of Hydraulic Installations on the Danube.

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BULGARIA

ECONOMIC RESULTS FROM APPLICATION OF NEW METHODS FOR HAIL CLOUD INDICATION

Sofia KHIDROLOGIYA I METEOROLOGIYA in Bulgarian No 6, 1980 pp 44-50

[Article by P. Simeonov, K. Stanchev, R. Petrov and P. Boev: "On the Economic Effect of Employing a New Hail Cloud Indication Method"]

[Text] 1. Introduction

Over the last 2 years (1978 and 1979) a new method for hail cloud indication (using s-band radar [$\lambda = 10$ cm]) and for studying the effect on the clouds has been employed at two neighboring hail suppression sites (HSS) in Gelemenovo and Golyam Chardak located in the Western Thracian Lowland. The method was worked out at the Institute for Hydrology and Meteorology. Even in the model studies of it, a number of its advantages [1, 4] were shown in comparison with the procedure presently employed in hail abatement in Bulgaria and which is based upon the K probability index for hail danger and x-band radar [$\lambda = 3.2$ cm] [8].

The aim of the current work is using the appropriate method to assess the economic effect of applying the new procedure at the above-mentioned HSS on the basis of the results of the 2-year period.

2. Advantages and Possibilities of the Method

The new method is based upon the physical statistical method of hail cloud indication [1, 4]. By discriminant analysis the critical value is determined for the A_{cr} function which separates the events of hail and rain. A procedure worked out in this manner which includes, in addition to the above method, also recommendations on the making of radar observations and on the effect on the hail clouds offers greater opportunities in comparison with the one used up to now. Basically the advantages can be expressed in two areas: the advantages of the physical statistical method and the advantages of the wave length of $\lambda = 10$ cm.

The physical statistical method is physically and mathematically sound. This is a prerequisite not only for a better separation of hail and nonhail clouds, but also for considering the fact of whether or not the necessary and sufficient conditions exist for hail formation and hail growth. The K probability index is mathematically unsound and this is often the reason that the hail danger of convective clouds has been incorrectly established [5]. The basic shortcoming is that with the moving of a value of one of the radar parameters below the critical ones for hail, that is, one of the conditions for hail formation or hail growth is absent, the K index can produce the probability of hail.

On the basis of the experimental check run on the physical statistical method, the following advantages can also be pointed to:

a) The discriminant function A provides an opportunity for an alternative (either only "yes" or "no") determination of hail danger from the clouds in contrast to K. This fact significantly facilitates the taking of a decision to initiate hail abatement proceedings;

b) The number of incorrectly treated clouds is reduced. A check has shown that in using the A function the overexpenditure is around 9 percent, but with K it can reach up to 70 percent [5, 6];

c) The determination of A is madc on the basis of four independent radar parameters, while the K is determined from seven of them, several being interdependent;

d) A can be estimated more easily and faster than K;

e) Avoided are the radar parameters which are related to temperature dependences and this is a prerequisite for automating the observation process.

Also of essential significance is the correct selection of the radar wave length for observing the hail clouds. The results of both our research [2] as well as foreign [7] unambiguously indicate the advantages of the 10-cm band over the 3-cm one for this purpose. And again it would be wise to point out the basic advantages which have been substantiated by actual operations as well:

a. The minimizing of radio wave attenuation in their propagation in the clouds and precipitation. This fact makes it possible to dependably record all hail-prone clouds within the effective range of the radar (for the radars employed, 45 km). The absence of screening provides an opportunity to more precisely determine those areas of clouds in which the crystallizing agents are to be applied. Our practice up to now has confirmed that in using the x-band for the indication of hail clouds, an average of twice a season one observes full screening (the radar "does not see" to a distance of greater than 8-10 km) and numerous partial screenings (the moving of the location of the zone with increased reflectivity toward the point of observation) with all heavy Cb clouds.

b. The reliability of the Rayleigh scattering for a larger portion of the spectrum according to the measurements of hydrometeorologists. On the one hand, this circumstance helps to increase the informativeness of the radar parameter lg z_m (z_m-- the factor of maximum radar reflectivity) which helps to better differentiate the hail clouds from the nonhail clouds [3]. On the other hand, this also contributes to the better selection of the clouds caused by the poorer reflectivity from the nonhail clouds with $\lambda = 10$ cm than with $\lambda = 3.2$ cm. This makes it possible to trace more objectively the evolution of clouds of convection and particularly to record more precisely the moment of their dissipation which leads to a savings in rockets as a consequence of the prompt halting of seeding.

3. The Method of Assessing the Economic Effect and an Analysis of the Results

With such innovations which do not totally alter the procedure of hail abatement, from the literature known to us up to now universal methods have not been proposed for assessing the effect with brief periods of testing in parallel with actual hail abatement.

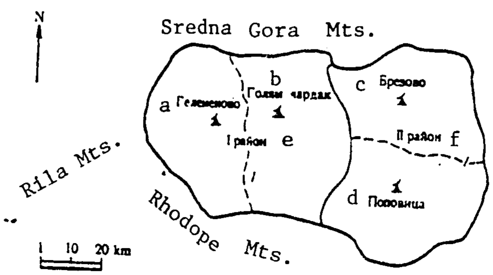

Fig. 1. Diagram of protected territories of the HSS in Region I and the HSS in Region II

1--Boundary between HSS of same region; a--Gelemenovo; b--Golyam Chardak; c--Brezovo; d--Popovitsa; e--Region I; f--Region II

The protected area of 2,280 km^2 of two neighboring HSS, Gelemenovo and Golyam Chardak, where the new method was applied, will be termed Region I. To the east of it lies a territory of 2,318 km^2 protected by the neighboring HSS, Popovitsa and Brezovo, and this will be called Region II (Fig. 1). The considerations for using these two regions for comparison are as follows:

a) During the active seasons of 1978 and 1979, in Region I the HSS used the new method, and in Region II, using the method with the K probability index and x-band radar.

b) The presence of climatic similarity between the two regions in terms of the hail processes and their manifestation.

The grounds for the second consideration can be checked out in comparing the historical data (over the 15-year period before hail abatement) for the following characteristics: the average annual number of days with hailstorms $\overline{G}*$, the average annual hail-struck area and the area reduced to 100 percent damage, respectively, $\overline{P}*$ and $\overline{P}*_d$. In addition, as more representative we have used the corresponding values normed for the protected area P:

$$\overline{G}*_p = \frac{\overline{G}*}{P}; \ \overline{p}* = \frac{\overline{P}*}{P}; \ \overline{p}*_d = \frac{\overline{P}*}{P}. \qquad (1)$$

Here it must be pointed out that for now we do not possess all of the necessary historical data for the above HSS. For this reason we have not found the more correct G* for the two regions by a comparison of the historical dates with hail in the years for the entire pair of HSS as well as by standardizing the P* and P^*_d in terms of the areas P_o seeded during the individual years. In spite of this, the values of the variables from (1) given in Table 1 provide reason to feel that there is a climatic similarity between the two regions in terms of the frequency of hailstorms and the intensity of damage from them. For this same purpose the ratios have been calculated between the total values of the [agricultural] product from one planted area, respectively, for Region II in comparison with Region I; these were 0.98 in 1978 and 0.78 in 1979.

Table 1

Comparison between Certain Climatic Characteristics for Hail Damage in Regions I and II

regions with HSS	P [km²]	$\overline{G}^*$ a [бр. дни]	$\overline{P}^*$ [km²]	$\overline{P}^*_d$ [km²]	$\overline{G}^*_p$ a [бр. дн./10³ km²]	$\overline{P}^*$ [%]	$\overline{P}^*_d$ [%]
I	2880	39	266,0	69,93	1,35	9,24	2.43
II	2318	39	256,4	54,07	1,68	11,06	2,33
II/I fold	—	—	—	—	1,24	1,20	0,96

Key: a--Number of days

Table 2

Scope of Hail Cloud Suppression Activities in Regions I and II During Active Seasons of 1978 and 1979

a	year	P [km²]	P_o [km²]	b D [бр. дни]	b G^* [бр. дни]	c N [бр. зони]	c N_s [бр. зони]	c N^* [бр. зони]	P^* [km²]	P^*_d [km²]	d Брой изстреляни ракети: O	A_1	A_2	e ПГИ-М	f R [хил. лева]
I	1978	2880	1658,9	30	12	289	131	22	231,1	114,1	703	219	3057	291	1426.0
II		2318	1410,4	34	8	374	223	16	233,9	96,7	509	1900	6919	—	2369.3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I	1979	2880	1697,4	43	18	520	191	37	99,4	24,8	1222	157	3467	338	2033,3
II		2318	1515,5	52	15	599	313	27	105,4	23,2	1552	1022	8088	—	3472.1

Key: a--Regions with HSS; b--Number of days; c--Number of zones; d--Number of rockets fired; e--PGI-M; f--Thousand leva

In addition to the above climatic characteristics, a notion of hail activity and the amount of work related to the loss of time in the two examined seasons can be obtained by the following values: the seeded area P_o; the days with an effect D; the zones--managed, seeded and caused hail damage--N, N_s, N*; the number of rockets fired "Oblako" [cloud] (O), Alazani 1 (A_1), Alazani 2 (A_2) and PGI-M; their cost--R.

The data for these characteristics from information in [10, 11] are shown in Table 2. In terms of the values of D and G* it can be seen that in 1978, the frequency of hail processes was around the average, and in 1979, was significantly greater. This can also be seen indirectly from a comparison of the data for D with the values of G* (Table 1). The data in columns 7-9 and 12-16 are representative for the frequency of the hail-prone zones and the scope of activities. The effects in 1979 were more intensive.

Generally speaking the two seasons are suitable for the purposes of the research.

The effect from the application of the new method for indication and hail suppression in Region I can be assessed by using the following values:

$$D_p = \frac{D}{P}; \quad n = \frac{N}{P}; \quad n_s = \frac{N_s}{P}, \tag{2}$$

where D_p, n and n_s are, respectively, days with seeding, the managed and seeded zones, standardized to a unit of protected area.

In this instance the most important economic indicators for the effect would be the difference in the expenditures on the rockets and the ratio between the rocket expenditures in Region II in comparison with Region I and standardized to a unit of protected area.

$$\Delta R = R_{II}-R_I \text{ and } (R_p)_{II}/(R_p)_I, \tag{3}$$

where $R_p = R/P$.

On the other hand, a comparative evaluation of the economic and physical effect relative to the amount of destruction can be made by correlating the following correct standardized values:

$$G^*_{po} = \frac{G^*}{P_o}; \quad p^*_o = \frac{P^*}{P_o}; \quad p^*_d = \frac{P^*_d}{P_o}; \quad S^*_v = \frac{S^*}{V}. \tag{4}$$

Here we can see the influence of the differences between the seeded areas in the two regions on the characteristics which depend on them as well as the influence of the overall value of the product V on the claims paid by the State Insurance Institute S*. Partially this approach has been employed in a comparative analysis of the effectiveness of hail suppression in various HSS [9]. In addition G*, P* and P^*_d have been standardized also for P in order to be compared with the data in Table 1.

The results of the estimates are given in Table 3. The ratios for the managed n and particularly the seeded zones n_s between the two regions unambiguously indicate the better selection of the hail-prone zones in Region I due to the new method. From the seeding of the zones described as highly "hail-prone" by the old method (with K), there is also an overstating of the number of days with an effect D_p. The economic expression of these consequences from actual practice is the over 2-fold greater expenditure of rockets in Region II (column 10). Or as the net

Table 3

Assessment of the Effect from the Application of the Indication Method Using S-Band Radar and Its Effect on Hail-Prone Clouds

region with HSS	year	D_p a [бр. дни/10 km²]	$G^*_{p_0}$ a [бр. дни/10³ km²]	G^*_p a [бр. дни/10³ km²]	n b [бр. зони/10³ km²]	n_s b [бр. зони/10³ km²]	n^* b [бр. зони/10³ km²]	ΔR c [хил. лева]	R_p d [лева/10³ km²]	p^*_0 [%]	p^* [%]	p_{d_0} [%]	p^*_d [%]	s^*_p [%]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
I	1978	1,04	0,72	0,41	10,0	4,55	1,33	943,3	4,95	13,93	8,02	6,88	3,96	3,51
II	1978	1,46	0,57	0,34	16,1	9,62	1,13		10,22	16,58	10,09	6,86	4,17	3,73
I	1979	1,49	1,06	0,62	18,0	6,63	2,18	1438,8	7,06	5,86	3,45	1,46	0,86	0,78
II	1979	2,24	0,99	0,65	25,8	13,50	1,78		14,98	6,95	4,55	1,53	1,00	1,18
II/I fold	1978	1,40	0,79	0,83	1,61	2,11	0,85	—	2,06	1,19	1,25	1,00	1,05	1,06
	1979	1,50	0,93	1,01	1,43	2,04	0,82	—	2,12	1,19	1,32	1,05	1,16	1,51

Key: a--Number of days; b--Number of zones; c--Thousand leva; d--Leva

profit from the savings in rockets during the two seasons in Region I we can use the total of ΔR or 2,382,000 leva. Now we can see that ΔR is more influenced by the frequency of the processes (1979) than by the intensity and strength of them (1978).

Just by the values of G^*P_0 and n^*, and respectively by their ratios for Region II in relation to Region I, it would be more difficult to draw conclusions concerning the effect from the use of the new method. This is only possible by comparing them with the data on the damage caused, and this also shows a greater successfulness of hail suppression in Region I. From another viewpoint, the contribution of better selection with seeding in Region I is apparent from a comparison of the ratios of D_p and n_s with those of G^*p_0 and n^*.

From the data on the range of objective indicators for hail damage in Table 3 (columns 11, 13 and 15) it can be seen that in Region I the damage is smaller. This is even better expressed by the ratio for p^* and p^*_d and which are comparable with their similar climatic indicators in Table 1. Here we must point out the heavy amount of damage from a catastrophic hailstorm (during the night of 14-15 June 1978) when the losses were 2-fold greater at the Golyam Chardak HSS in comparison with those at the Popovitsa HSS. It is also known that such processes cannot be successfully influenced by the present seeding methods on a world scale [12, 13]. In this instance the process started and was seeded by the Gelemenovo HSS, it passed over the above two HSS and did not appear at all over the Brezovo HSS, a station often left in the "shadow" of strong hail processes (for example, of 19 July 1971, 22 June 1977, 23 June 1977 and others) in comparison with the other three HSS.

In spite of the designated particular features, the results given in Table 3 from the evaluation show the higher efficiency and dependability of the seeding in using the new method.

4. Conclusion

The introduction of the new method for indicating hail-prone clouds using X-band radar and hail cloud suppression carried out at the Gelemenovo and Golyam Chardak HSS in 1978 and 1979 demonstrated its advantages in practice. As a consequence mainly of better selection of the hail-prone zones and the more accurate determination of the beginning and ending moment of their seeding, the following was achieved:.

a) A 2-fold greater savings in rockets during the two seasons with a total value of 2,382,000 leva;

b) Lower losses from hail damage in comparison with the HSS of the compared region.

The effect was significant with seasons having a greater frequency and intensity of hail processes. The mass introduction of the method into the system of hail abatement is a prerequisite for achieving a multiplier economic effect.

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